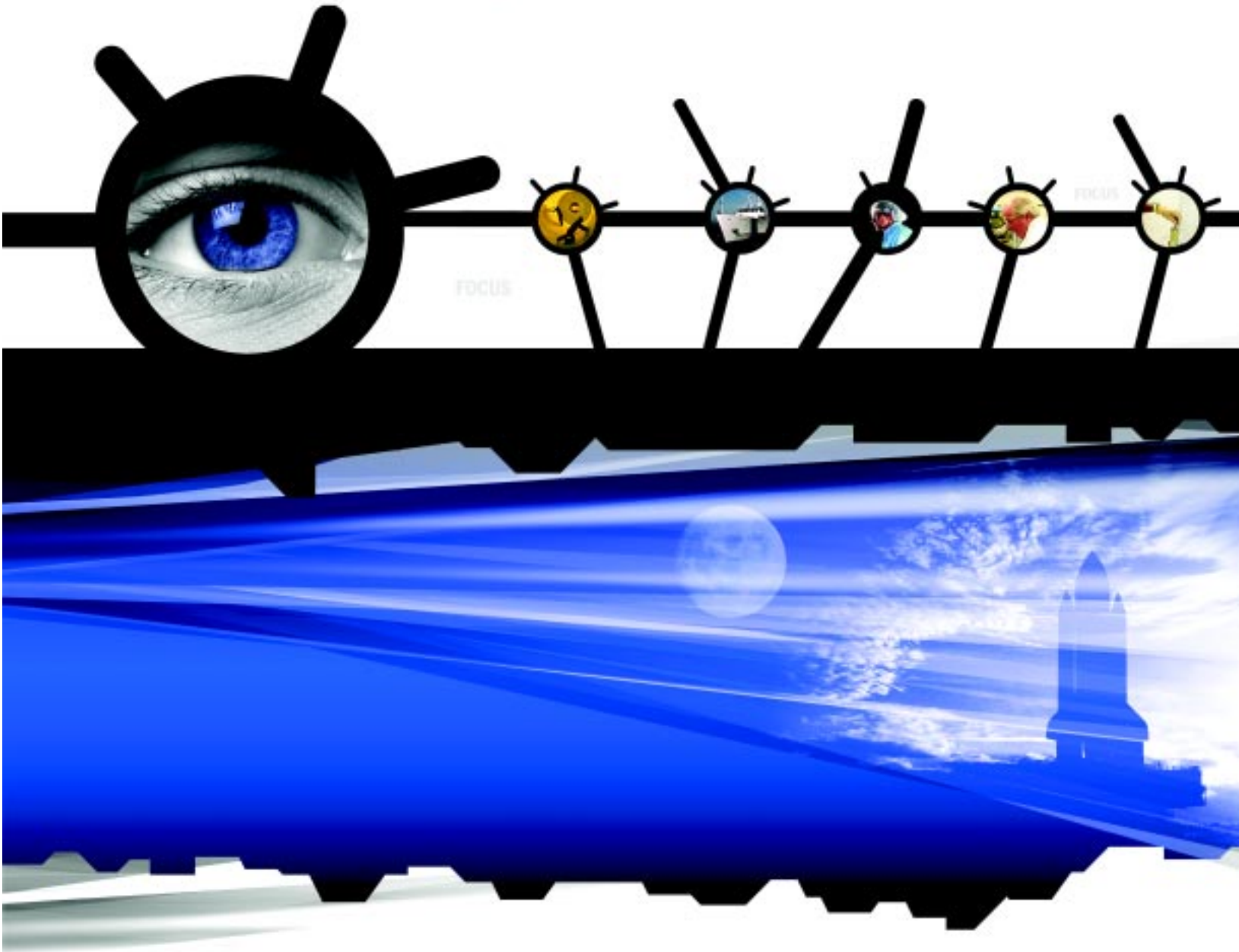
SPACE SHUTTLE PROGRAM
2003 Annual Report

Process Control Focus Group



PROCESS CONTROL
Mission Success Depends On You


NASA
United States

Space Shuttle Program

Process Control Focus Group 2003 Annual Report

Approved by:

_____

Jon Cowart, PCFG Chair
Kennedy Space Center, Florida

PROCESS CONTROL
Mission Success Depends On You


USA
NASA
iscovery

Table of Contents

STS-107 Launch

Executive Summary

The year 2003 will be remembered as a year when the nation lost the Orbiter Columbia with seven astronauts aboard during their re-entry to earth from an extremely successful mission. This has been a difficult year, but through the leadership, dedication, and effort of the National Aeronautics and Space Administration (NASA) and contractors, the Space Shuttle Program will continue into the future.

The Process Control Focus Group (PCFG) continues to have members who are dedicated to improving process control within their organizations and within the thousands of suppliers who provide products or services to the Space Shuttle Program. The following organizations and centers continue to have representatives on the NASA-led PCFG: ATK Thiokol Propulsion; Boeing Rocketdyne; Hamilton Sundstrand Space Systems International; Lockheed Martin Space Systems Company, Michoud Operations; Pratt & Whitney; United Space Alliance with the Boeing Company as a major subcontractor; Johnson Space Center (JSC); Kennedy Space Center (KSC); Marshall Space Flight Center (MSFC); and Stennis Space Center (SSC). In addition, two associate members from the Jet Propulsion Laboratory participate representing the NASA agency-wide Supplier Outreach Process Control (SOPC) initiative.

The face-to-face activities continued this year with the Second Annual Supplier Symposium being held at Kennedy Space Center on May 20-22, 2003. There were approximately 250 suppliers in attendance. The prime contractors also conducted individual supplier visits with astronauts participating when available. The latest process control products are shown and distributed during these visits, which aid the supplier in their own awareness program.

Two videos were produced this year, “Countdown 3: Know Change” and a special tribute video “To Fly.” A pocket guide titled “My Role In Process Control” is a unique product developed in partnership with the SOPC representatives. This pocket guide has been distributed extensively across the aerospace industry and the feedback has been tremendous. The PCFG will continue to design and develop products that are educational and inspirational to the workforce.

STS107- (16 January – 1 February 2003) -The STS-107 crewmembers strike a ‘flying’ pose for their traditional in-flight crew portrait in the SPACEHAB Research Double Module (RDM) aboard the Space Shuttle Columbia. From the left (bottom row), wearing red shirts to signify their shift’s color, are astronauts Kalpana Chawla, mission specialist; Rick D. Husband, mission commander; Laurel B. Clark, mission specialist; and Ilan Ramon, payload specialist. From the left (top row), wearing blue shirts, are astronauts David M. Brown, mission specialist; William C. McCool, pilot; and Michael P. Anderson, payload commander. Ramon represents the Israeli Space Agency. EDITOR’S NOTE: On February 1, 2003, the seven crewmembers were lost with the Space Shuttle Columbia over North Texas. This picture was on a roll of unprocessed film later recovered by searchers from the debris.

Introduction

The world witnessed a tragedy on February 1, 2003 with the unexpected break-up of Columbia over the skies near Dallas, Texas where all seven astronauts perished. The mission was dedicated to science and had completed a full schedule of experiments from the scientific community and students from around the world. The STS-107 mission was extremely successful until the horrific ending, which has reminded us all of the enormous risks that are taken for the exploration of space. Each member of the NASA/Contractor family felt the loss personally and will never forget Columbia, her crew, and the lessons such an event must inevitably teach us. These seven astronauts wholeheartedly believed in what they were doing and sacrificed their lives in pursuit of their dreams. The memory of David Brown, Rick Husband, Laurel Clark, Kalpana Chawla, Michael Anderson, William McCool, and Ilan Ramon will live on in all of us.

Immediately following the accident, a team of hundreds of volunteers began searching the woods, fields, and towns of Texas and Louisiana searching for debris that would prove to be vital in determining the cause of the accident. The amount of debris recovered was significantly more than expected particularly when considering that over 700,000 acres were searched. As the debris was being recovered, teams were identifying and analyzing the debris, while others examined telemetry and recovered data and video. As new tests and analyses were performed, the results were compared against old data.

In the midst of this effort tragedy struck again when a helicopter crashed claiming the lives of Jules “Buzz” Mier, Jr., a contract pilot, and Charles Krenek, a Texas Forest Service employee.

After six months of extensive analysis the final report from the Columbia Accident Investigation Board (CAIB) was released (available online at www.nasa.gov). This independent investigation determined the cause of the break-up of Columbia to be foam debris from the left bi-pod area of the external tank striking the wing leading edge. The CAIB report not only explained the cause of the accident, but also identified findings, observations, and recommendations. There are fifteen recommendations that are classified as return to flight actions while the remaining items are considered by the board as more long-term issues that need to be addressed. The agency and contractors have embraced the report and are committed to implementing whatever is necessary to ensure a safe return to flight in 2004.

The CAIB report emphasized culture and the impact it has on human behavior and the employees’ willingness to step forward and express their concerns. The PCFG has been encouraging and rewarding individuals who bring forth concerns and prevent an escape from occurring thereby promoting a culture of communication and openness. The products developed by the PCFG are designed to educate the workforce on the individual’s responsibility to ensure that all requirements are adhered to and call attention to something that “doesn’t look right.” As the CAIB report indicates, culture is an intangible entity that is difficult to quantify, yet it plays an important role in the daily operations of every organization. The PCFG will continue to create products that inspire the workforce and influence the culture in a positive manner.

Program Management

The leadership of the PCFG was transitioned to the JSC Orbiter Project Office at KSC effective January 1, 2003 and although there have been management changes within NASA's Space Shuttle Program, the Process Control Focus Group continues to have complete support from the NASA Shuttle Program Manager and the NASA Centers. Since the inception of the PCFG in November 1999, there have been a few new members including the associate members from the Jet Propulsion Laboratory (JPL), who bring a different perspective and experience base to the group. The Supplier Outreach Process Control program led by JPL was established in 2002 as a spin-off of the PCFG to reach the suppliers and universities supporting NASA's Robotic Exploration of Space. Partnering with other organizations will ensure the process control message permeates throughout the aerospace industry.

The PCFG continues to meet face-to-face quarterly to discuss process escapes, best practices, and develop concepts for the most effective awareness products. The discussion of escapes is beneficial to everyone for a couple of reasons. One is that it may prevent another contractor from experiencing the same situation or the corrective action may point out a weakness within an organization that requires immediate attention. The second reason is that these discussions may highlight similar types of escapes, thereby being the area of emphasis in the development of future products

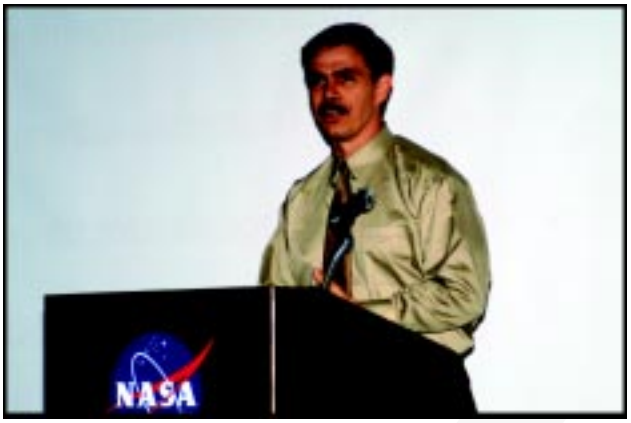
Standing left to right: Mike Osgood, Hamilton Sundstrand; Mike Gemme, Hamilton Sundstrand; Tom Malatesta, NASA JSC; Rob Sobieski, Boeing Rocketdyne; Brian Sterkel, Boeing Rocketdyne; Neil Bussiere, Boeing Rocketdyne; Mike Amman, Lockheed Martin Michoud Operations; Terry Keeney, NASA KSC; Joyce Rozewski, NASA JSC; Kien Nguyen, JPL; Dan Specksgoor, Pratt & Whitney; Buck Crenshaw, JPL; Tammi Belt, United Space Alliance. Kneeling left to right: John DeGiovanni, Boeing Rocketdyne; Glen Curtis, ATK Thiokol; Lililee Johnson, United Space Alliance; Jon Cowart, NASA JSC; Lionel Ribeiro, Hamilton Sundstrand; Shailesh Parikh, Lockheed Martin Michoud Operations; Anh Huynh, NASA JSC.

Awareness Campaign

The second annual Space Shuttle Program Supplier Symposium was rescheduled to May 20-22, 2003 due to the tragic loss of Columbia and her crew. The theme, “Pioneering the Future” symbolized the aspirations of everyone to move forward with human exploration of space. Although the symposium was during an emotional time, it provided an opportunity for 250 suppliers to come together in support of the Shuttle Program and hear about the future. Attendance this year increased to over 500 people representing suppliers, prime contractors, and NASA.

Process Control was emphasized during the contractor break-out sessions as well as during the symposium. Throughout the two days, suppliers were able to receive videos, posters, pocket guides, mini-discs, and other products that can be utilized within their organizations and suppliers to promote awareness. The latest video in the Countdown series was previewed as well as a tribute video entitled, “To Fly.”

The contractors continued to conduct supplier visits throughout the year reaching nearly 150 suppliers one-on-one, which is the preferred method of communication. Although the demand for astronauts was wide spread, approximately 30 of those suppliers visited were fortunate enough to meet an astronaut, whom is extremely successful in motivating and encouraging the workforce. In addition, return-to-flight visits were conducted to provide up-to-date information on the most recent activities and reiterate the importance of their continued support and dedication to the program. There is a challenging road ahead that will involve redesigning hardware and developing new procedures with the focus on enhancing safety for future crews and missions.



Jon Cowart, NASA JSC and PCFG Chair, presents “Process Control-A Key to Pioneering Space Shuttle to 2020” at the Supplier Symposium.

John DeGiovanni of Boeing Rocketdyne presents “Systems Driving Towards Process Control” at the Supplier Symposium.

Astronaut Cady Colman, Lt. Col. U.S. Air Force walks through the shop at Whalley Precision in Southwick, MA.

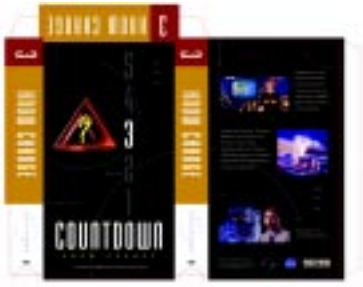
Awareness Products

Early detection, communication, and effective prevention are key to preventing process escapes from occurring. Individuals who are aware and pay attention to detail are the best defense in recognizing and correcting a potential problem. The products that the PCFG develops are designed to reach all employees on some level whether their function is an engineer, technician, inspector, or administrative. The latest product is a pocket guide entitled, “My Role In Process Control.” This pocket guide illustrates the multiple processes that are required for the successful completion of producing a product or service and reinforces the individuals’ responsibility. The pocket guide demonstrates negative and positive behavior at each step of the process, illustrates the five elements of a process including questions and identifies tools available to prevent and react to process escapes as well as the results of doing nothing, which is high scrap rates, rework, and customer complaints.

The eight process control standards, which were revised this year, are included in the pocket guide. The standards were rather lengthy and may have been difficult to understand so while the intent of the standard remains the same they were rewritten as follows:

Standard 1:	Detect and eliminate process variability and uncoordinated changes.
Standard 2:	Eliminate creep through process controls and audits.
Standard 3:	Understand and reduce process risks.
Standard 4:	Identify key design and manufacturing characteristics and share lessons learned relating to processes.
Standard 5:	Be personally accountable. Perform to written procedures.
Standard 6:	Promote process control awareness. Understand and report changes.
Standard 7:	Identify and evaluate changes to equipment and environment.
Standard 8:	Capture and maintain process knowledge and skills.

The latest video in the Countdown series was released in August and is titled, “Know Change.” There are several driving forces behind changes that need to be made, such as new environmental protection laws, obsolescence, and suppliers no longer providing products/services. Changes are inevitable, however understanding the changes and the impact to the entire product is imperative. Even seemingly innocent changes can create unforeseen results. The example featured in “Countdown III: Know Change” illustrates the impact of an oven change out, which by itself wouldn’t appear to pose an issue. Unfortunately, the oven was not identified as either Fahrenheit or Celsius and the circuit board was exposed to much higher temperatures than required and was ultimately scrapped. Examples like this highlight the importance of considering all possible sources of an escape introduced through incorporating a change.



The Celebrity Watch portion of this video is devoted to an employee who noticed a broken weld on a rail car, which transports the Reusable Solid Rocket Motor from Utah to Florida. Celebrity Watch highlights individuals who have taken proactive measures and brought forward a concern to prevent an escape. Christopher Bryant at Kennedy Space Center was working on pressure lines under the railcar when he realized that the weld holding the car on the base was broken. After an extensive investigation and thorough inspection, some weld fractures were found in all the rail cars. Employees like this, who look beyond the scope of their task and call attention to something that doesn't look right are the kind of people and behavior the Space Shuttle Program needs to ensure a safe and successful mission every time. If you know someone who has called a Time Out to prevent an escape, visit www.CountdownOnline.tv and nominate him or her for Celebrity Watch.

Julia Park presents Chris Bryant with the Celebrity Watch Award. Far right photo: Ben Vlkojan (center) recieves the Space Shuttle Program Process Control Champion Award.

In addition to Celebrity Watch, the Space Shuttle Program Process Control Champion Award can recognize individuals for reporting a problem or concern that ultimately prevents an escape. This award was developed to acknowledge multiple individuals from across the program vs. a single Celebrity Watch feature. Ben Vlkojan from Pratt & Whitney is the first recipient of the Champion Award. He is being recognized for stopping the final assembly of a Space Shuttle Main Engine Turbo pump by sensing that the bolt torques provided in the work instructions were incorrect. This attention to detail minimized the number of pumps built using the wrong torque values and prior to engine hot fire. The PCFG will continue to recognize individuals like Ben Vlkojan to further promote and reward this type of behavior.

The tribute video, "To Fly" is a short inspirational piece with workforce testimonials on what process control means to them. It was shot at several locations from coast to coast, which illustrates how companies all across the country are involved in the Space Shuttle Program. These individuals represent the thousands of people who are dedicated and proud to be a part of America's exploration of space. It takes all of us working together to ensure mission success and as Peggy Ritchie stated in the video, "process control is everyone's job."

Process Control Tools

The Space Shuttle Program Standards & Practices document was developed to provide the supplier with the eight process control standards and examples of best practices that have been implemented across the program to meet the standard. These examples provide the "what" so the supplier can develop a program that is applicable to their organization. This document is available on-line at process.nasa.gov or by contacting a PCFG representative.

The process.nasa.gov website is available to the public and is one mechanism that the PCFG utilizes to communicate upcoming events and furnish the supplier with information on process control tools and techniques. An area of emphasis for the coming year is to continue populating the "Process Control Tool Box" with information on topics such as Human Factors, Root Cause Analysis, and Risk Assessments. The feedback from the survey provided during the Supplier Symposium identified specific areas of interest, which will be the first priority to complete. The intent of the Tool Box is to provide meaningful information that is generic, but capable of being tailored for a specific business. The examples in the Tool Box are certainly not all inclusive and the PCFG is always seeking new methodologies for improving process control and welcomes input and suggestions.

Above: Installing the igniter into a Reusable Solid Rocket Motor forward segment. Right photo: Solid Rocket Booster (SRB) stacking continues in Kennedy Space Center's (KSC's) Vehicle Assembly Building.

Contractor Initiatives

Boeing Rocketdyne

On the Space Shuttle Program, the quality of the hardware and the safety of everyone is the primary focus for all our decisions. Each action we take, everything we do, affects the hardware we produce. A successful shuttle launch comes from the interactions of a lot of individual decisions. For each decision we make, we balance the risks and the benefits. Sometimes those decisions produce clearly undesirable events, scrapped hardware, injured people, inadequate analyses or product malfunction. When we look back at those undesirable events, we find talented people who wanted to do good things yet unintentionally acted in ways that increased risk. Sometimes an unacceptably high risk was not identified. Sometimes it was identified but considered acceptable. In either case, quality and safety suffered. Boeing Rocketdyne has prepared a training session for Space Shuttle Main Engine (SSME) managers and their work teams to increase awareness of at risk behavior on the part of everyone – managers and non-managers, to offer ways to minimize risky behavior, and to begin to change our habits as managers and non-managers alike.

The training session takes a close look at understanding why individuals behave in a risky manner. Often when a mistake is made and the individual is asked, why did it happen, the response is “I just wasn’t thinking.” Perhaps the person had performed the task so many times that they behaved as if they were on autopilot.

When we are on autopilot, we are not thinking of the task at hand. We see or hear something, and we respond without thinking. In performing a critical operation this behavior can lead to catastrophic results. Another common risky behavior involves individuals with can-do attitudes. Companies value can-do employees who overcome obstacles and go the extra mile to get the job done. However, can-do attitudes can also result in undesirable events when employees choose to take short cuts or don’t take the time to properly evaluate the risks associated with the task at hand. Employee behavior is also influenced by the group situation, and by the things we say to one another. Consider the difference in employee behavior you might expect from the following requests: “Get the task done by the end of the day no matter what” and “tell me what you need to make sure the task gets performed safely and correctly.” The message behind the first comment perpetuates a culture of can-do attitudes while the latter focuses the priority on quality and safety over rushing to meet a deadline. Providing employees with an understanding of at-risk-behavior is only half of the battle. The greater challenge is for each of us to make risk consideration a habitual practice in everyday decisions.

Above: The first Space Shuttle Main Engine (SSME) is installed on Space Shuttle Atlantis following the welding repair of the propulsion system flow liners as preparations to launch mission STS-112 continue. Photo right: Workers in the Vehicle Assembly Building oversee the replacement of Main Engine No. 1 in Space Shuttle Atlantis.


KSC
D-080

United Space Alliance

In late 2002, the leadership team was challenged to achieve world-class Quality in processes and products across the company and Lean Six Sigma (L6S) was selected as the methodology to achieve this challenge. Lean Six Sigma is a system for process improvements that builds on the existing continuous improvement atmosphere, adding new tools, techniques, and a specific program management approach. It provides a structure and methodology for company-level process and product quality improvements tied directly to company goals.

Lean Six Sigma is a combination of two highly successful process improvement methods used by a number of aerospace companies and in a variety of industries. "Six Sigma" focuses on the elimination of variation and defects while "Lean" production methods improve process speed and efficiency.

A L6S Senior Champion was named as well as five Deployment Champions who have been chosen to lead the development and implementation of L6S projects across the company. Over the course of this year, 39 black belts were named and sent through seven weeks of training. Nineteen employees made up the first wave of Black Belts to undergo the extensive and rigorous training program and tests, with 100 percent of those candidates successfully completing the program. The second wave of Black Belts completed their training on October 10, 2003 and once again, 100 percent passed the training program.

Prior to the first wave of training, a wide-ranging selection process began to determine which projects would most benefit from the L6S philosophy. Over the course of the year, 39 projects, one for each Black Belt were chosen. The L6S program uses a model called DMAIC – Define, Measure, Analyze, Improve, and Control. The Define stage includes steps such as identifying the problem and developing customer lists. The final step, following the Measure, Analyze, and Improve milestones, is Control, which includes implementing process changes and controls, calculating final financial returns, and transitioning the project to its future owner.

While the L6S program is still in its infancy at USA, tremendous results have already been experienced. The following are six examples of projects that have improved employee safety, reduced cycle time, reduced defect and scrap rates, and identified thousands of dollars in cost avoidance and cost savings.

- **NASA Standard Initiator Team**
- **Orbiter Tile Removal/Replacement Team**
- **HI-Y'er (Electrical Hardware Inspection) Team**
- **Operations, Maintenance, Requirements & Specifications Buy-Off Team**
- **Software Process Facility Ops Media Methodology Enhancement**
- **Reduce Cycle Time for Cockpit Avionics Upgrade Level 6 Testing**

Green Belt selection and training has already begun. Green Belts will manage less complex projects than Black Belts with time horizons between two and three months. Green Belt training will emphasize the basic L6S process improvement tools with less emphasis on the highly statistical tools available to the Black Belts.

Freedom Star retrieves a solid rocket booster for refurbishment.

Lockheed Martin Space Systems Company, Michoud Operations (LMSSC, MO)

Michoud Operations launched the Process Risk Assessment (PRA) program with suppliers during the Supplier Symposium held at Kennedy Space Center. During the symposium, five suppliers volunteered to participate in the PRA process for the product they deliver in support of External Tank.

The Process Risk Assessment is not an "audit" and is performed by a Process Expert Team with representatives from the supplier and LMSSC, MO. The purpose of a PRA is to perform an objective risk assessment of the processes utilized at suppliers to manufacture, assemble, test and process flight hardware and establish the state of the process (i.e., "in-control" or "at-risk"). If a process is determined to be "at-risk" it would be further assessed within the scope of a comprehensive review such as a technical or self-assessment plan.

An "at-risk" process is defined as a process that is subject to anomalies that may cause or contribute to: a) the inability to warrant that the product satisfies specified requirements, b) specific problems in documentation, c) specific problems in performance of required processes. All processes utilized at suppliers to manufacture, assemble, and test External Tank flight hardware will be assessed.

A process that is considered to be "in-control" is identified as a process that provides safe and reliable hardware that is verifiable and is adequately documented.

The Ground Rules and Assumptions are as follows:

- Processing of External Tank parts at suppliers' begins with Receipt of Contract from LMSSC, MO and continues through Receiving Inspection and Part Quality Inspection at the Supplier/Processor prior to shipment.

  - Including interrelated processes that can provide work authorizing instructions e.g. Nonconformance Document

- Members on Process Expert (PE) Teams Include:
  Supplier: Production Operations, Safety & Product Assurance, Technical Operations (where appropriate), Practitioners

  LMSSC, MO: Procurement Quality Control Field Representative, Process Risk Assessment Facilitator (as required), Technical Operations and Material Representative (as required).

The Space Shuttle's external tank is moved on a barge toward the turn basin at Kennedy Space Center from Port Canaveral, Fla.

Forward Planning

As the Space Shuttle Program implements changes recommended in the CAIB report and through NASA's Return-To-Flight Plan, the Process Control Focus Group will continue to focus on strategies to improve awareness of process control and influence the culture. Several new products are being developed that will not only target the worker "on the floor," but will include management and engineering disciplines. The activities to date have focused solely on hardware build, certification, and test, but there are other processes, which are subject to escapes and creep ("normalization of deviance") where the PCFG may focus in the future. Also in 2004, the PCFG will produce and release a video in collaboration with Space Flight Awareness centered on the lessons learned from the Columbia tragedy.

The partnership with the JPL-led Supplier Outreach Process Control will continue as well as establishing relationships with other organizations. An update of the recent activities is performed quarterly at the Quality Leadership Forum, which is chaired by the Office of Safety and Mission Assurance at NASA Headquarters and the PCFG members are always willing to speak at conferences when requested.

Although 2004 will be a difficult and challenging year in the history of the Space Shuttle Program, we all must remain diligent and continually raise the bar striving for a successful return to flight. Remember to ask yourself, "What will I do today to help return to safe flight?"

Technicians lowering the forward exit cone into the Reusable Solid Rocket Motor nozzle.

Technician performing window cavity check valve acceptance test.

Technician performing window pain hypervelocity impact damage measurements. Photo right: Preparing an insulated Reusable Solid Rocket Motor segment for the autoclave.

Appendix A

PCFG Members:

Johnson Space Center
Jon Cowart, Team Lead
321-861-3040
jon.cowart@nasa.gov

Thomas Malatesta
714-372-5234
tmalates@ssd.bna.boeing.com

Kennedy Space Center
Terry Keeney
321-861-5382
terry.keeney-1@nasa.gov

Marshall Space Flight Center
Ken Crane
256-544-8025
ken.crane@msfc.nasa.gov

Rick Williams
818-586-9799
rick.a.Williams@boeing.com

NASA Headquarters
Tom Whitmeyer
202-358-2228
tom.whitmeyer@nasa.gov

Stennis Space Center
Mike Smiles
228-688-1642
Michael.d.smiles@nasa.gov

John Stealey
228-688-2236
john.e.stealey@nasa.gov

ATK Thiokol Propulsion
Glen Curtis
435-863-6954
glen.curtis@atk.com

Boeing Rocketdyne
John DeGiovanni
818-586-2697
john.j.degiovanni@boeing.com

Robert Sobieski
818-586-2059
robert.j.sobieski@boeing.com

The Boeing Company
James Shearer
281-853-1741
james.t.shearer@boeing.com

Hamilton Sundstrand
Space Systems International
Michael Gemme
860-654-5437
Michael.gemme@hs.utc.com

Lionel Ribeiro
860-654-3326
lionel.ribeiro@hs.utc.com

Lockheed Martin Space Systems
Michoud Operations
Michael Amman
714-822-2595
Michael.g.amman@maf.nasa.gov

Shailesh Parikh
504-257-1849
shailesh.a.parikh@maf.nasa.gov

Pratt & Whitney
Dan Dannecker
561-796-2087
William.dannecker@pw.utc.com

Dan Specksgoor
561-796-8652
Daniel.specksgoor@pw.utc.com

United Space Alliance
Tammi Belt
321-867-8326
tammi.j.belt@usa-spaceops.com

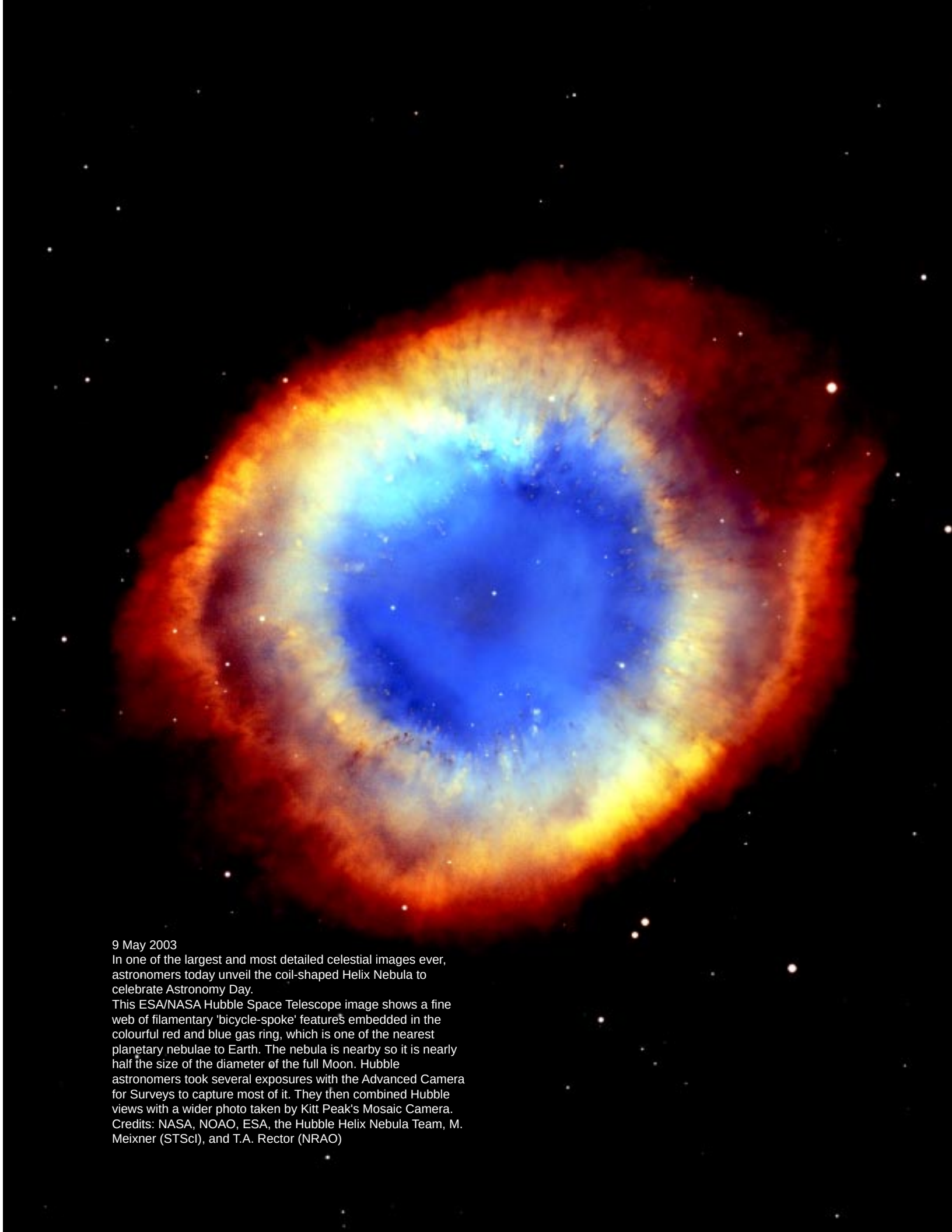
Lililee Johnson
281-212-6212
lililee.Johnson@usa-spaceops.com

Fusion Productions
Todd Sims
817-424-5774
ntsims@film-videoproduction.com

Associate Members:

Jet Propulsion Laboratory
Harrel “Buck” Crenshaw
818-354-7225
harrel.b.Crenshaw@jpl.nasa.gov

Kien Nguyen
818-393-7264
kien.nguyen@jpl.nasa.gov



9 May 2003
In one of the largest and most detailed celestial images ever, astronomers today unveil the coil-shaped Helix Nebula to celebrate Astronomy Day.
This ESA/NASA Hubble Space Telescope image shows a fine web of filamentary 'bicycle-spoke' features embedded in the colourful red and blue gas ring, which is one of the nearest planetary nebulae to Earth. The nebula is nearby so it is nearly half the size of the diameter of the full Moon. Hubble astronomers took several exposures with the Advanced Camera for Surveys to capture most of it. They then combined Hubble views with a wider photo taken by Kitt Peak's Mosaic Camera.
Credits: NASA, NOAO, ESA, the Hubble Helix Nebula Team, M. Meixner (STScI), and T.A. Rector (NRAO)